

Two Billion Cars: Is it Sustainable?



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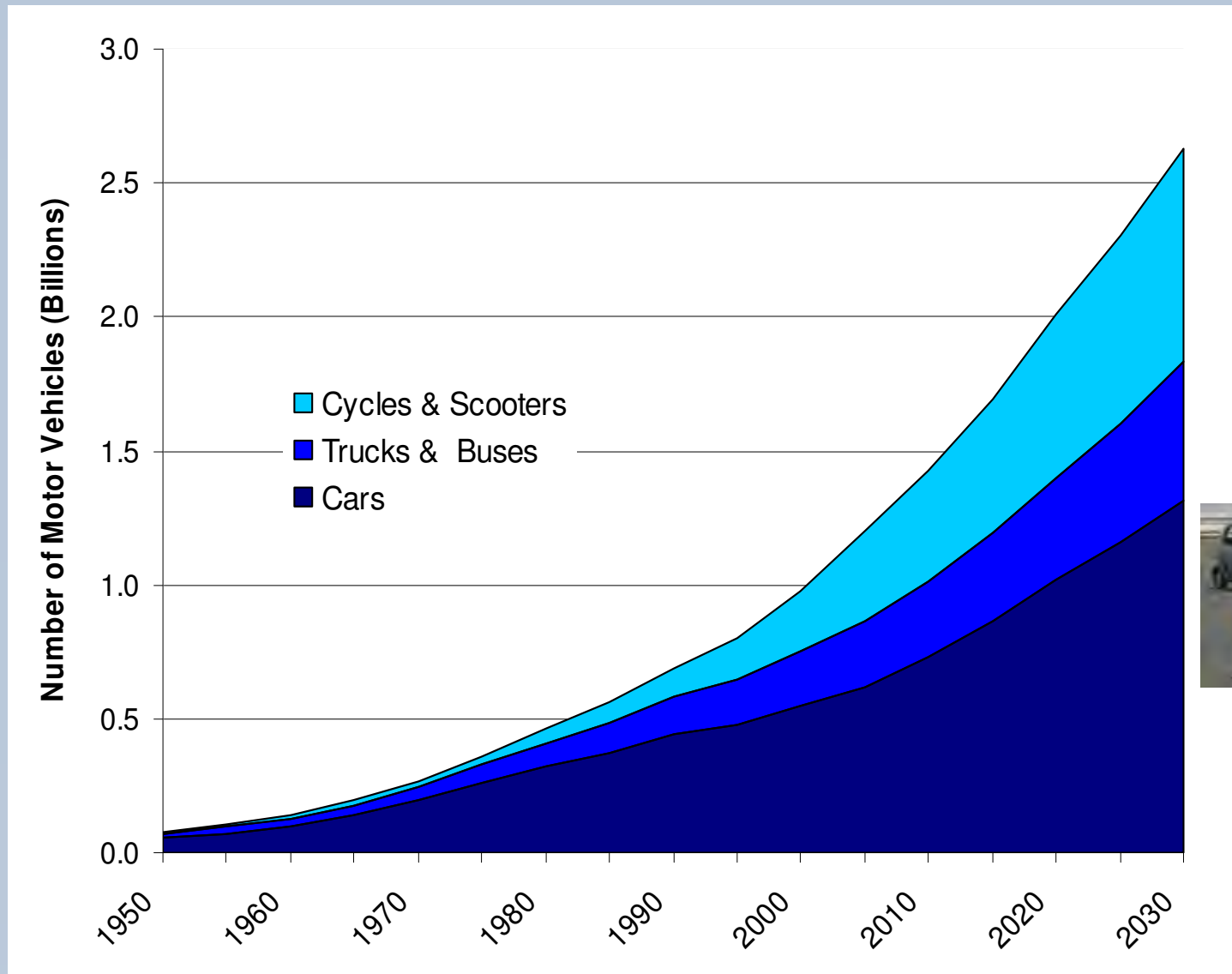
April 13, 2009



1919 Convaircraft flying car



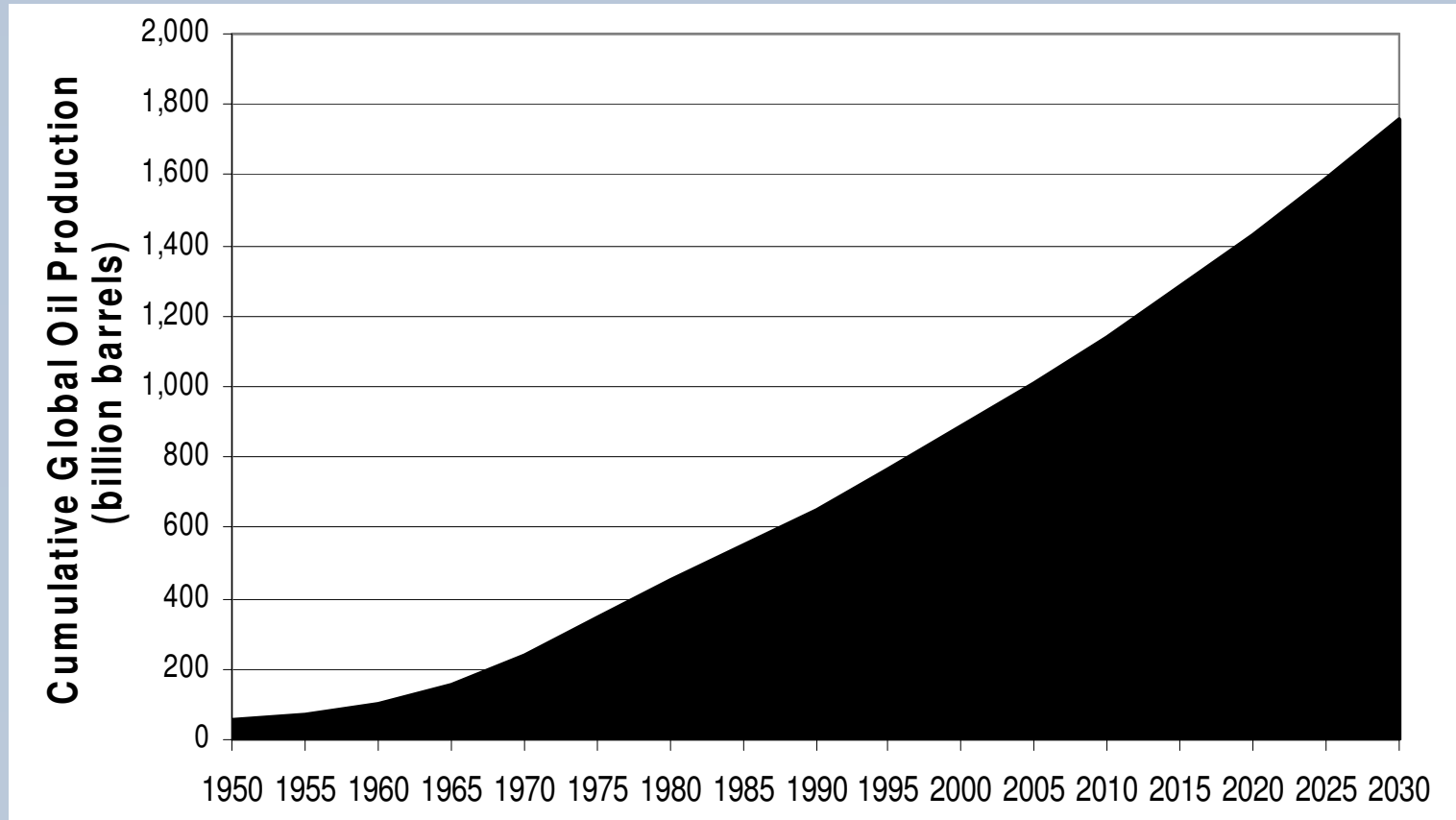
2 Billion Vehicles in 2020 (globally)!



Source: Sperling and Gordon (2009), based on DOE, JAMA, other projections

In next 10 years, world will consume 1/4 of all oil consumed through its entire history

Cumulative global oil production, 1950–2030



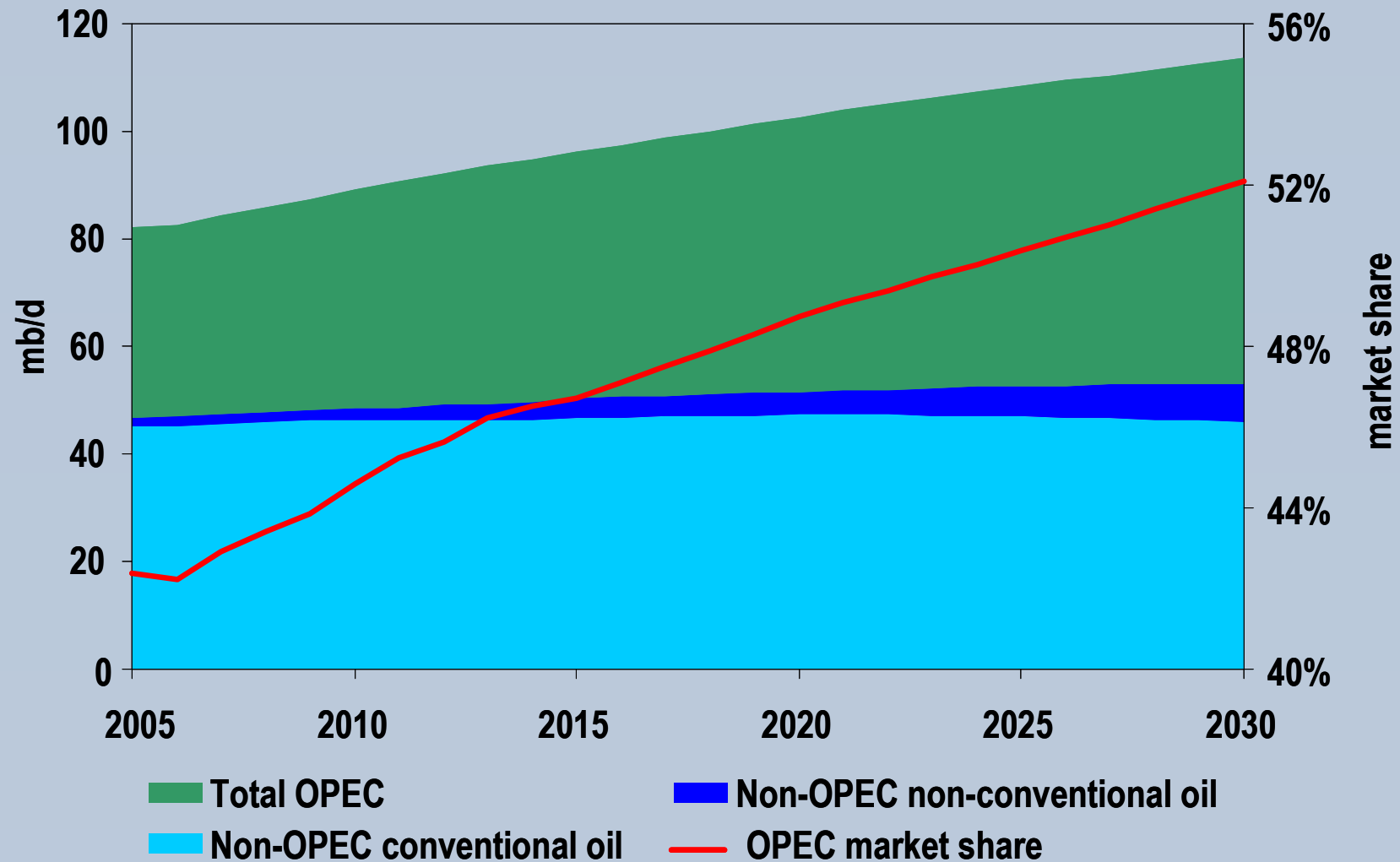
Source: Sperling and Gordon (2009), based on U.S. DOE/EIA data

Cars and Oil: A Blessing and a Curse



Oil Problem #1:

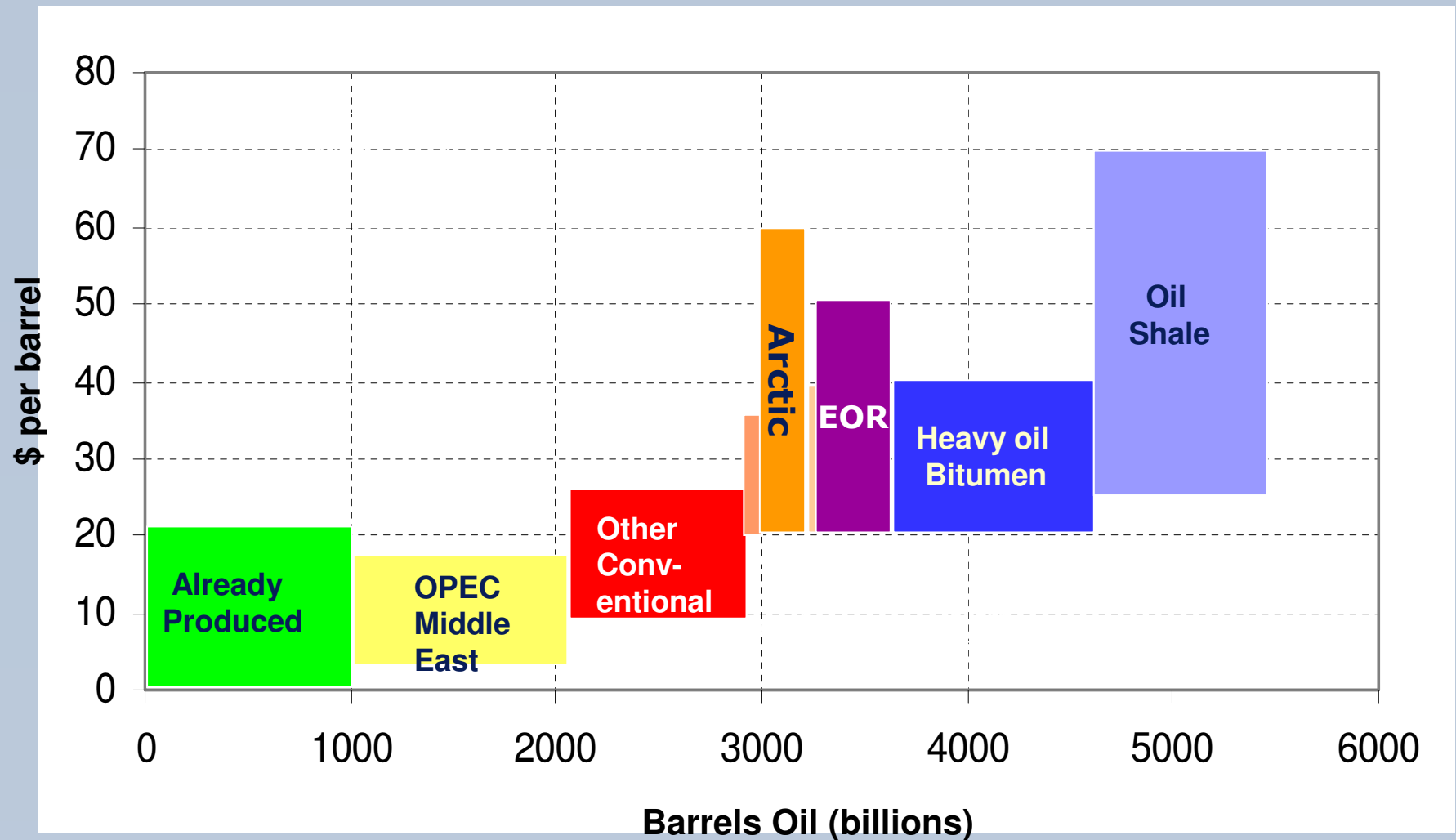
Middle East Gaining More Control of Oil Production



Source: IEA reference scenario

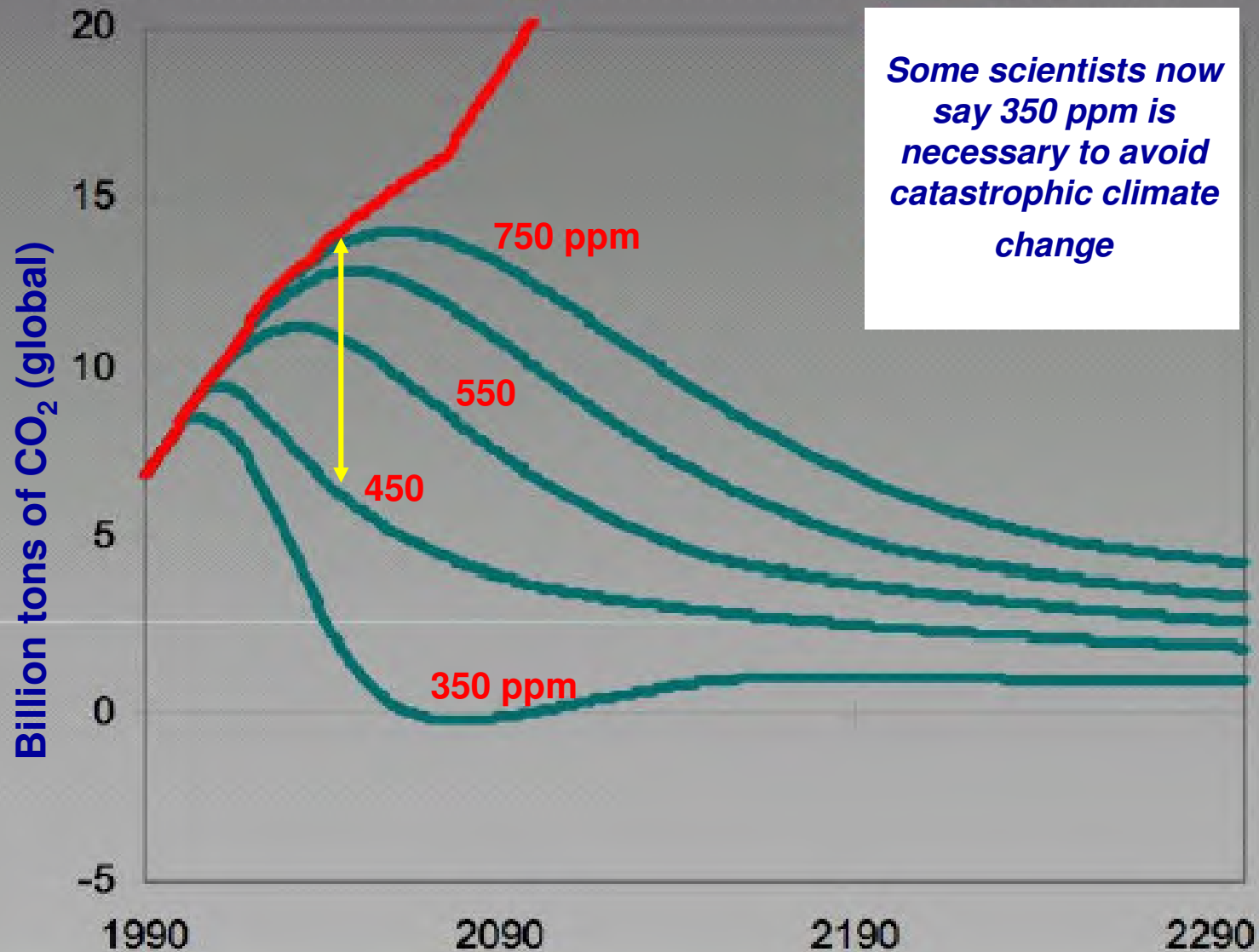
Oil Problem #2: Shift to High-Carbon Unconventional Oil

Supply “Curve” of World Hydrocarbon Resources

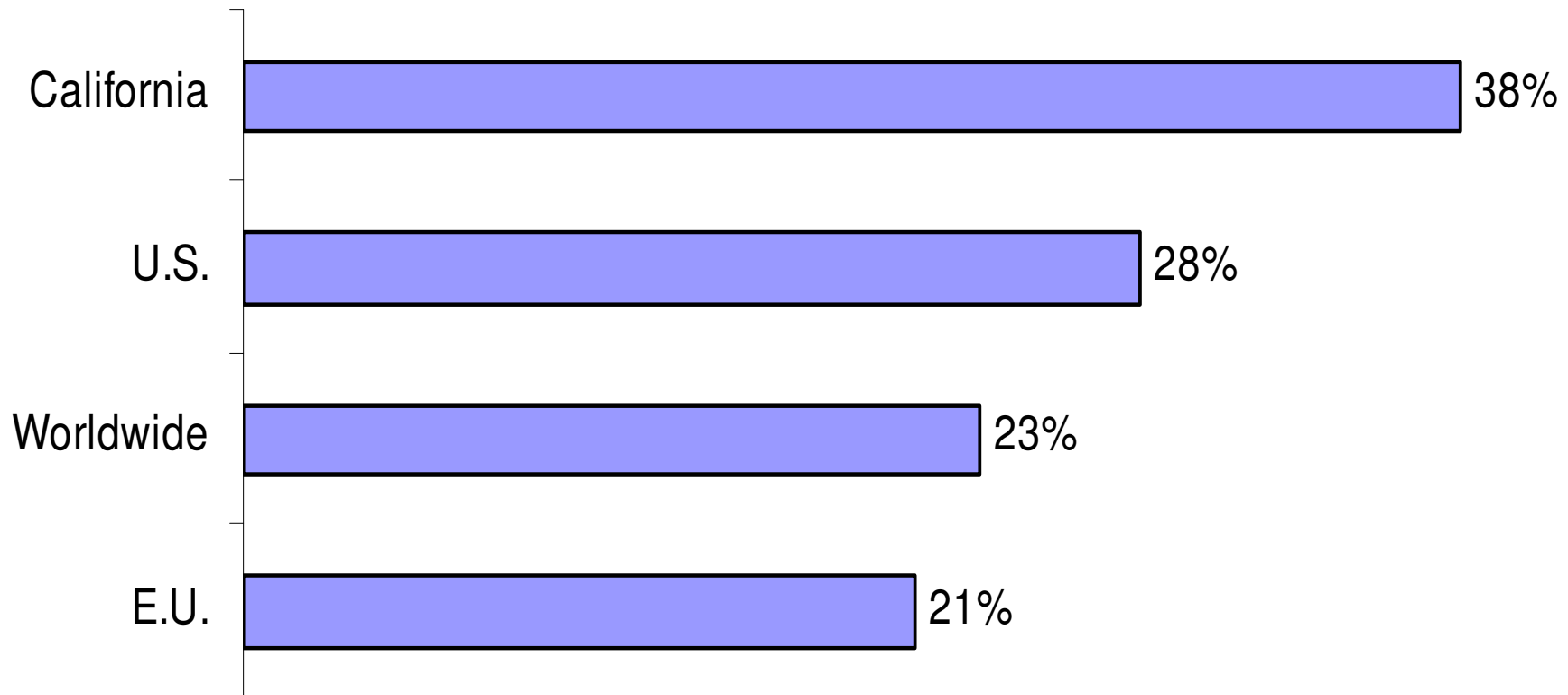


IEA, 2005

Humans Need to Dramatically Reduce CO₂ Emissions to Stabilize the Climate



Transportation's Large Role in Climate Change



**Greenhouse gas emissions rose more rapidly
in transportation than any other sector – up 120%
between 1970 and 2004**

Transforming Transportation



- Transforming vehicles (*“easiest”*)
- Transforming fuels (*hard*)
- Transforming mobility (*hardest*)

First Leg

Transforming Vehicles

Cars of future will be far more efficient and will be powered mostly by electric-drive

“...If we work together, we can make the 21st century the age of the electric vehicle.”

Toyota Chairman Shoichiro Toyoda, October 1996



Electric vehicle experiment of 1990s largely failed ... but led to improved batteries and electric drivetrains which are now making comebacks in hybrids, fuel cell vehicles... and battery-electric vehicles!

DCX GEMs in
Factory, 2002



Toyota



Honda



Bombardier



Pivco/Th!nk



GM EV1



Nissan



Will Plug-in Vehicles Succeed?



- **In China? Yes!**
- **As small battery-electrics? Yes!**
- **As blended hybrids? Yes!**
- **As Volt-type hybrids? Hmm... some day**

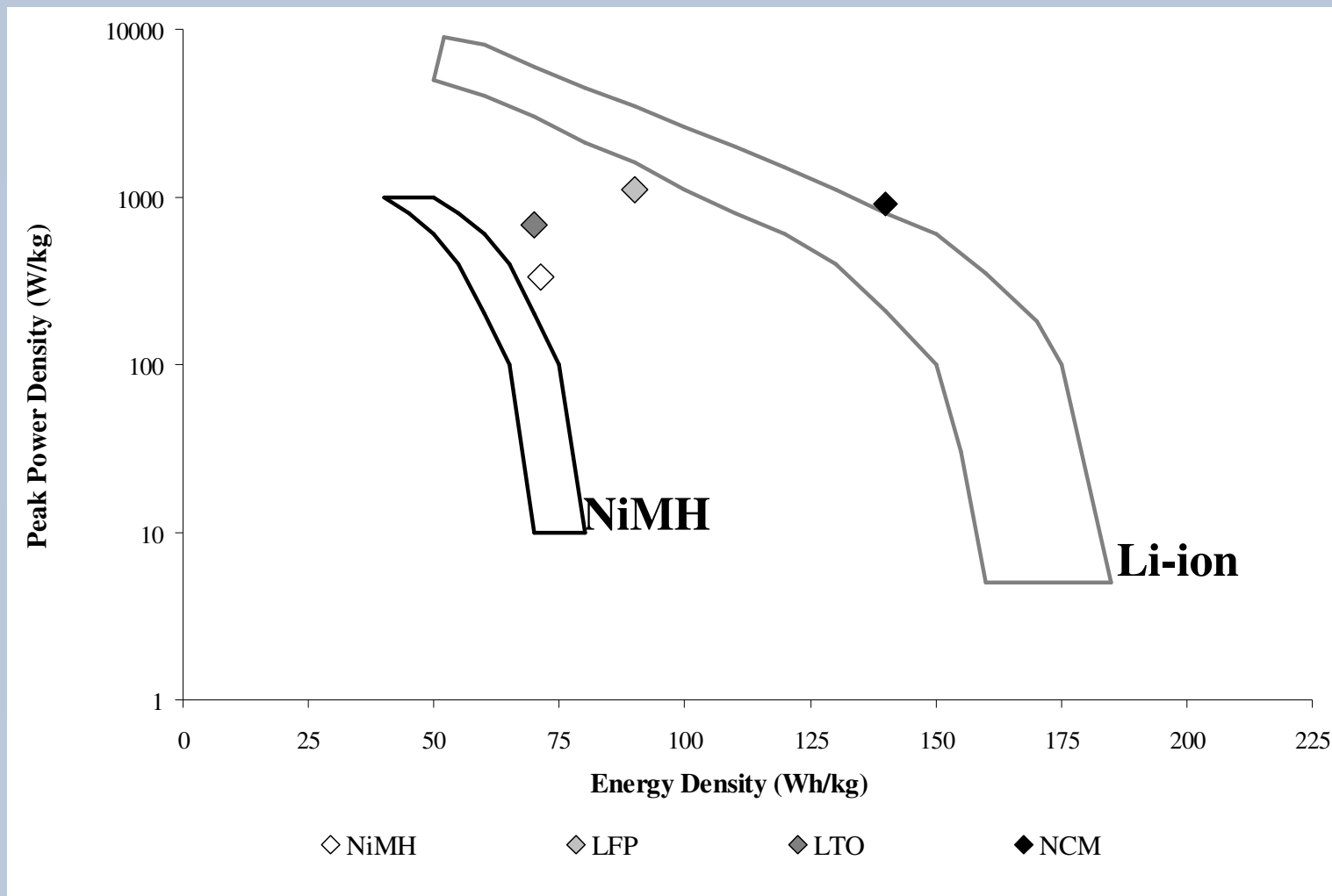
Battery cost must drop, durability must increase

Another Transformation: Connecting Vehicles to Buildings and Electricity Grid



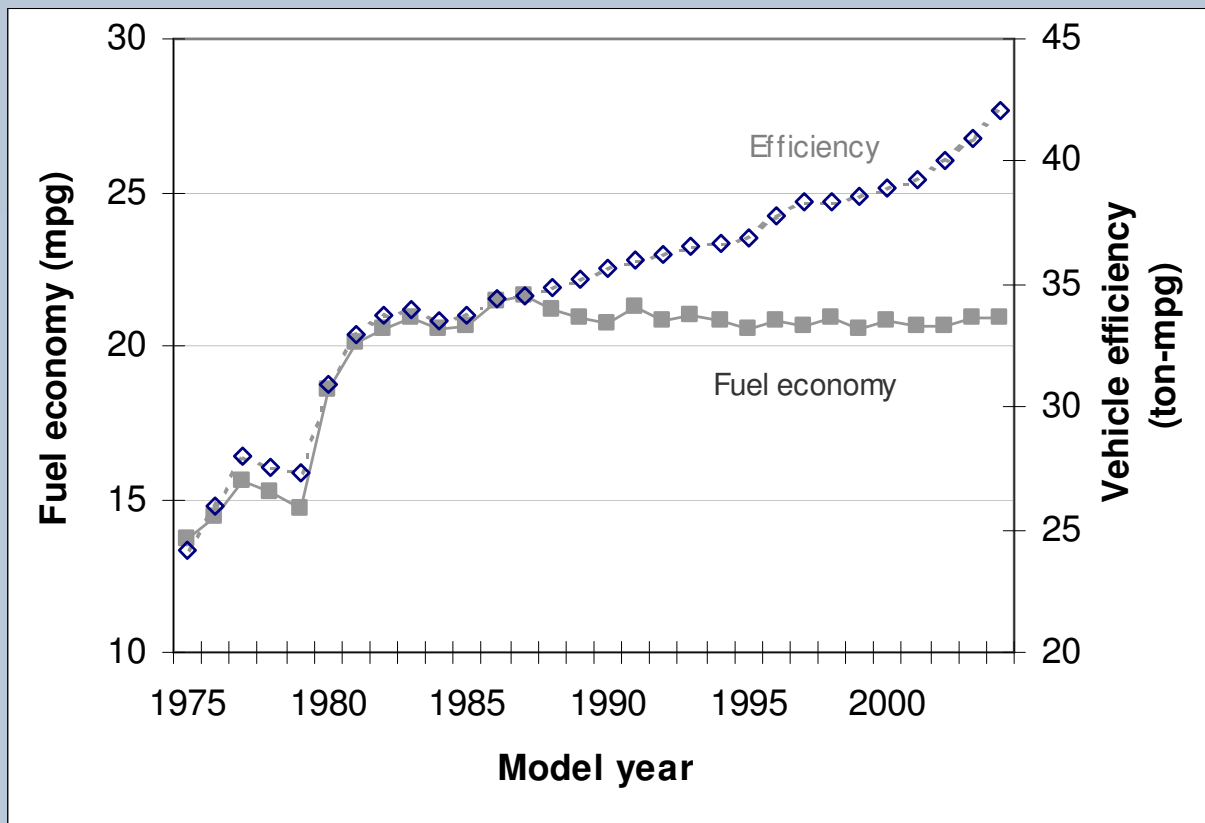
Cautionary Note:

Battery Progress is Impressive, but Next Generation Batteries are Still Expensive



LFP= lithium iron phosphate (cathode); LTO= lithium titanium oxide (anode);
NCM= lithium (nickel, cobalt, manganese) (cathode)

...But it's also about fixing today's cars



Source: Lutsey and Sperling, 2007

Most studies now say that 50% improvement is possible with gasoline ICEVs by 2030, with much greater improvements provided by hybrids, diesel, BEVs, PHEVs, and FCVs



Can we stop the horsepower race and use efficiency innovation for improved fuel economy? Policy plays key role!

Transforming Vehicles...Next Steps

US

- 35 mpg by 2020 – Is this enough?
- Tax credits for hybrids, fuel cell, battery-electric vehicles
- Increased R&D investments – batteries and lightweight materials

California and Other States

- ~42 mpg by 2020 (if Obama approves)
- Zero Emission Vehicle requirements



“Detroit Churches Pray for ‘God’s Bailout’”

SUVs on altar of Greater Grace Temple, a Pentecostal church in Detroit, as congregants prayed to save the auto industry. NY Times, 12/7/08

...SUV sales up in December 2008

Second Leg

Transforming Fuels

The Stone Age did not end for lack of stone, and the Oil Age will end long before the world runs out of oil.

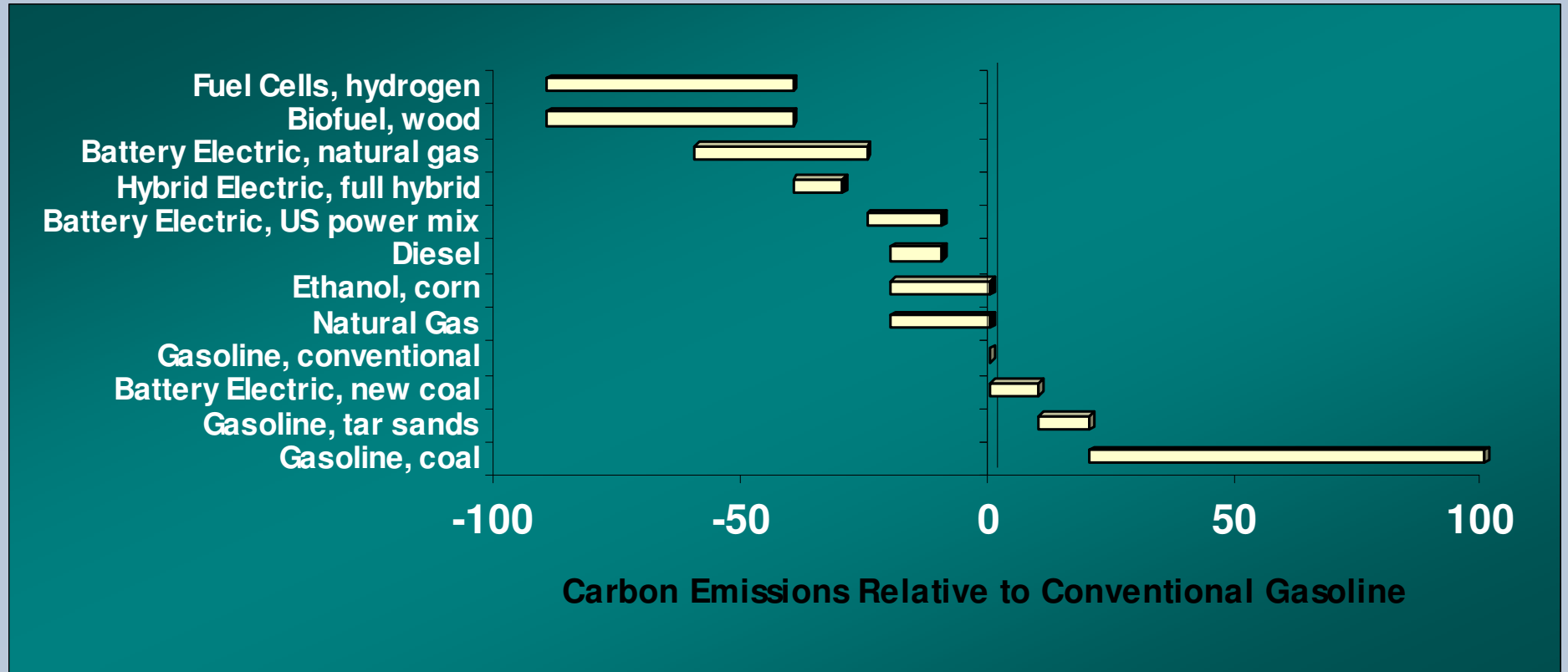
Sheikh Zaki Yamani, Saudi Arabian oil minister for 3 decades

- Today: 97% dependent on oil
- Future: Wide mix of fuels to power mobility



Many Promising Replacements

Some better than others...



***Fuel du jour* Phenomenon**

Disruptive and wasteful

- **30 years ago – Synfuels (oil shale, coal)**
- **20 years ago – Methanol**
- **15 years ago – Electricity (Battery EVs)**
- **5 years ago – Hydrogen (Fuel cells)**
- **2 years ago – Ethanol**
- **Today – Electricity (Plug-in hybrid vehicles)**
- ***What's next?***

**GOVERNMENT POOR AT PICKING WINNERS ...
NEED DURABLE POLICY SUCH AS LOW CARBON FUEL STANDARD**

Low Carbon Fuel Standard

Design Features

- Based on lifecycle measurements
- Imposed on oil refiners
- Companies can buy and sell credits

Advantages of LCFS concept

- Inspires innovation
- Robust/durable
- Life-cycle oriented
- Doesn't pick winners
- Encompasses all fuels: NG, petroleum, unconventional oil, biofuels, electricity, H₂

Challenges

- Limiting leakage and gaming
- LU impacts of biofuels not yet well understood
- Integrating California LCFS with other sectors, states, and countries

CARB's Proposed LCA Numbers for LCFS

• Gasoline	96 gCO₂-eq/MJ
• Corn EtoH	77-105 (47-75 plus 30)
• Calif Corn EtoH	81 (51 plus 30)
• Brazilian EtoH	73 (27 plus 46)
• EVs	35-41
• H ₂ FCVs	33-62
• Cellulosic biofuel (draft)	20-40 (incl iLUC)

Third Leg: Transforming Mobility (and Land Use)

*In U.S. and abroad,
we've created a
transportation
monoculture where
“**sprawl is the law.**”
Many opportunities for
innovation!*



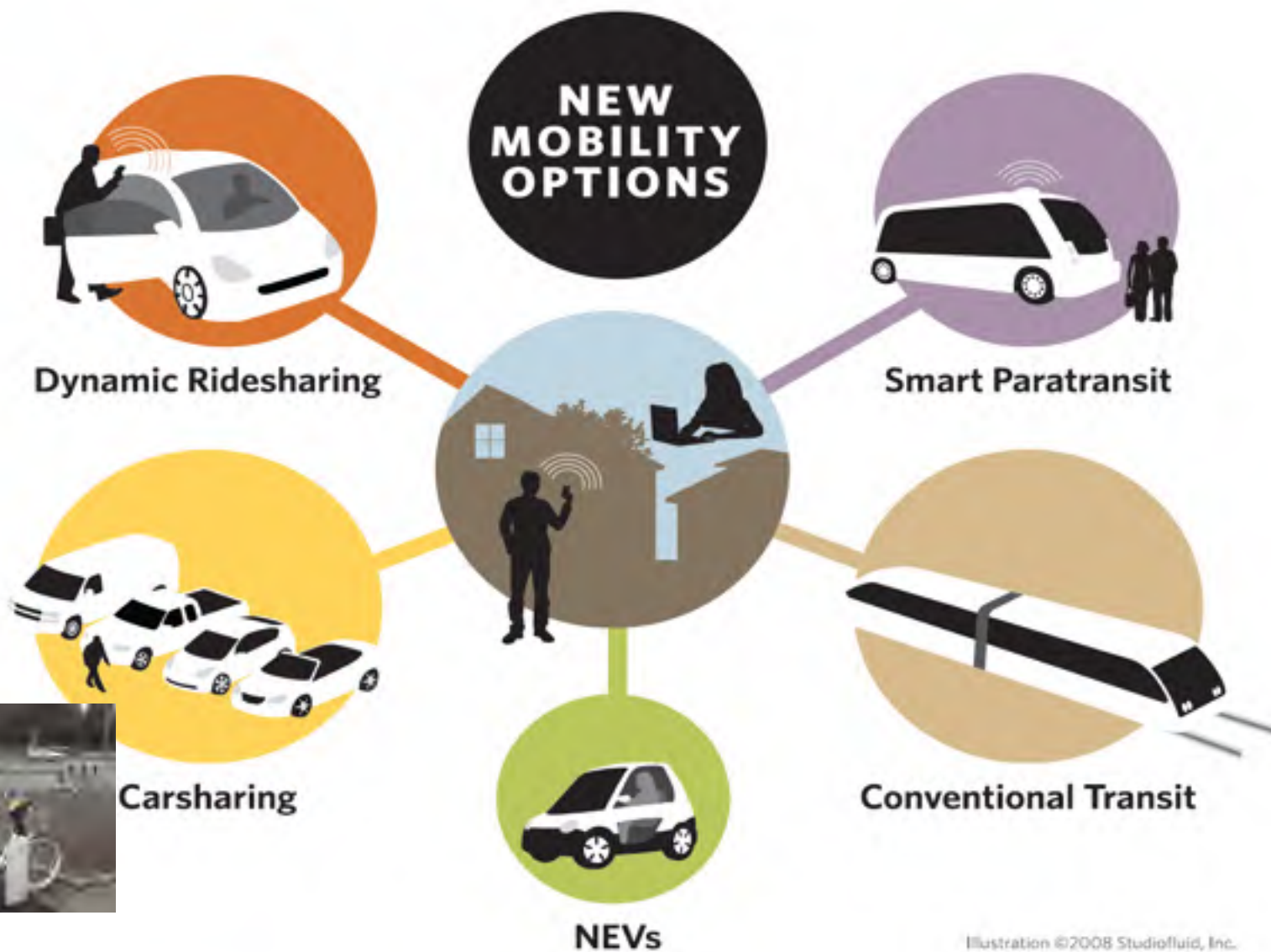
California Leadership on VMT Reduction

- SB375 (Steinberg) targets reductions in VMT via changes in land use, transit, and possibly pricing
- AB32 also targets
 - High speed rail
 - Goods movement improvements

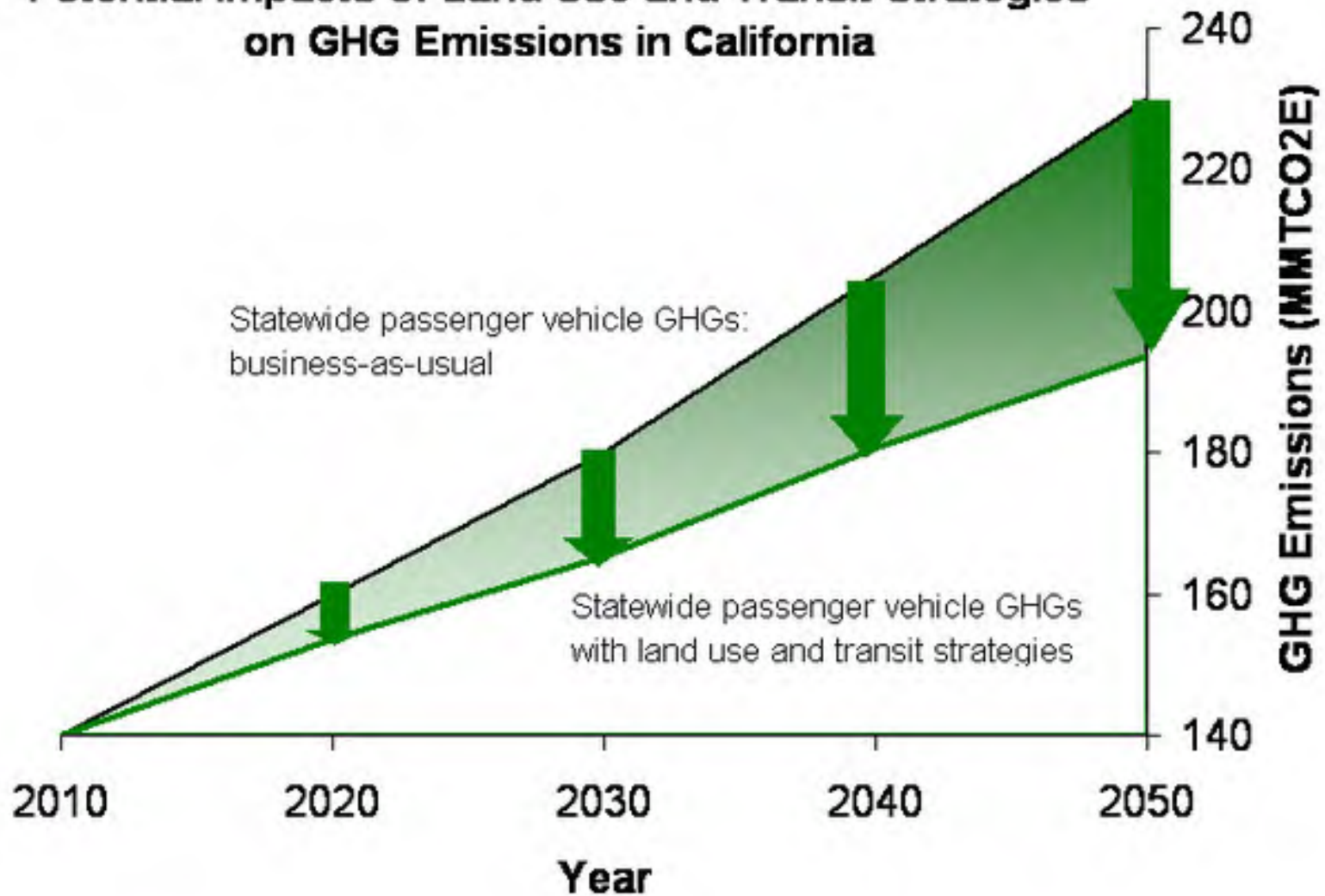
Not all vehicle trips are “high value”!



Key Strategy: Expand Traveler Choice



Potential Impacts of Land Use and Transit Strategies on GHG Emissions in California

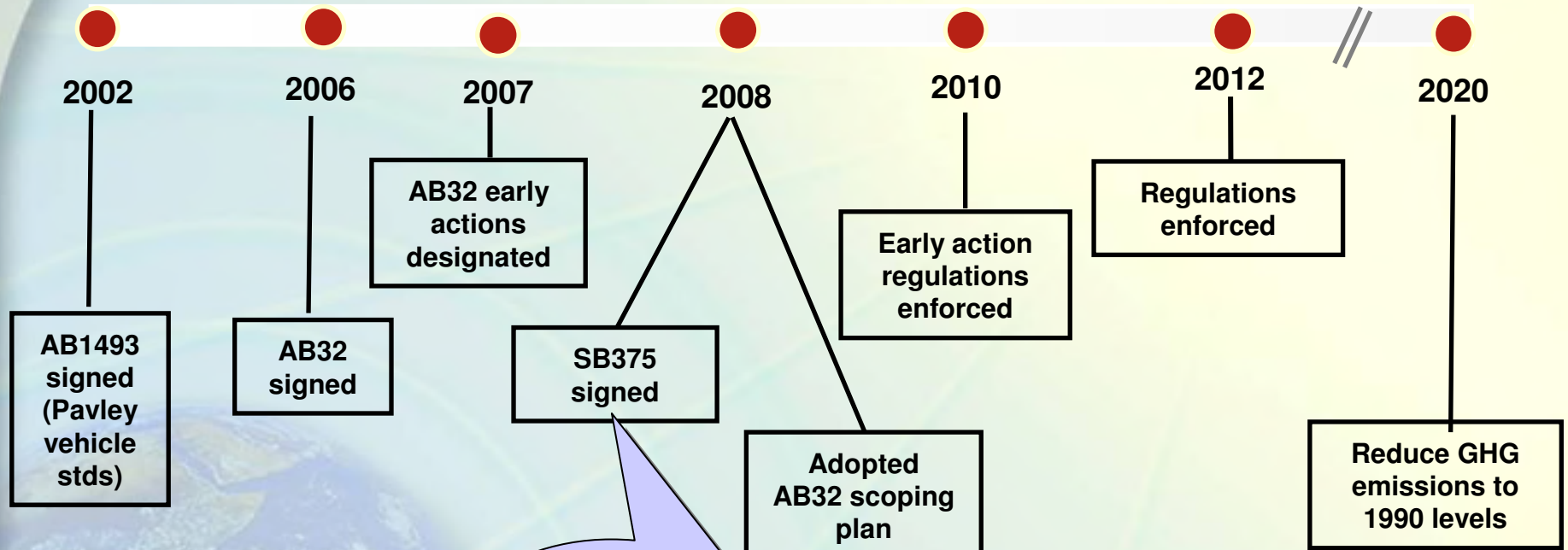


Source: ARB Scoping Plan, based on Rodier (2008)

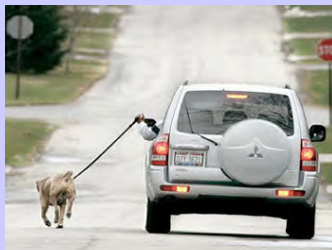
Question of Will and Vision, More Than Cost

- Consider hydrogen and fuel cells, which many think is most expensive and difficult transition ...
 - \$55 billion extra over 15 years for vehicles and fuels, to get to 10% market penetration (NRC/NAS, 2008)
- Meanwhile, US spends ~\$10 billion/year on subsidies for corn ethanol

California GHG Policy Timeline

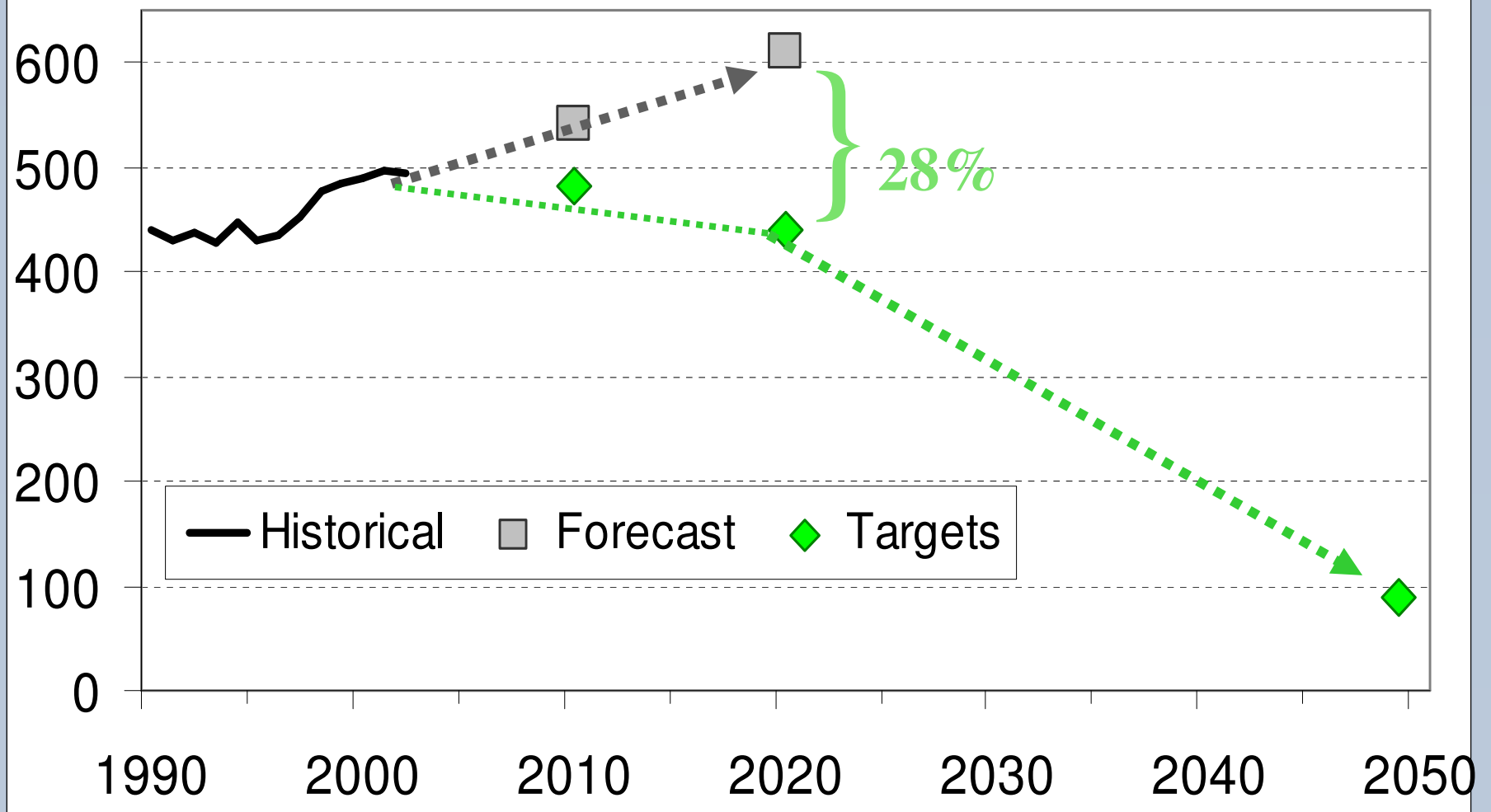


Reduces VMT



California's GHG (and Oil) Goals

California GHG Emissions (MMTCO₂e/yr)

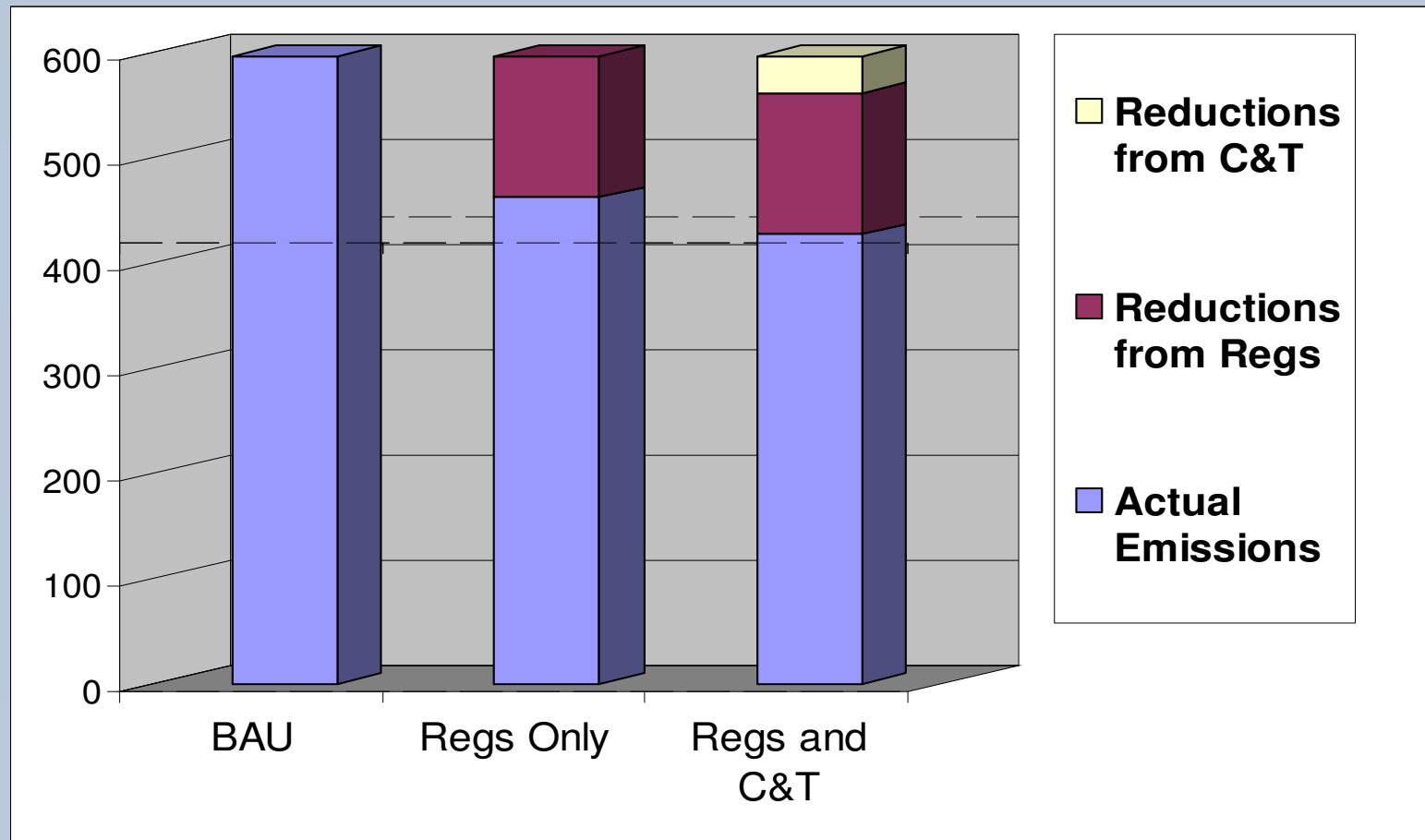


The California Approach

the pioneer of car-centric cities is now (trying to) pioneer low-carbon transportation

- Stimulate innovation in technology, behavior, institutions
- Target specific GHG reductions with broad array of rules and incentives
 - Energy efficiency stds, Renewables Portfolio Standard, Low Carbon Fuel Standard, etc
- Overlay cap-and-trade program (and offsets) to create price signal for carbon and to equilibrate costs across sectors (and gain additional reductions)

Cap and Trade is “Small” Part of Targeted GHG Reduction



Dashed line is 2020 target (427 MMT).

Transportation GHG Policy in California (mostly within AB32)

- Vehicles (cars and trucks) **39 MM tons**
 - Light-duty vehicle GHG stds (Pavley I and II)
 - ZEV rules
 - Feebates?
 - Truck Technology
 - Aerodynamic design
 - Improved efficiency for heavy duty trucks
 - Hybridization of urban and short-haul trucks
- Fuels **16+ MM tons**
 - Low Carbon Fuel Standard
- VMT and goods movement **5 MM tons (↑)**
 - VMT reduction via land use, transit, pricing (SB375)
 - Low-emission req'ts at ports, eco-driving, tire inflation, etc



Key Policy Questions

- Future of California's Pavley standards (GHG/mile) in California and nationally?
- Future of US RFS and California LCFS?
- Effectiveness of SB375 VMT/LU policy initiatives?

Lesser Policy Questions

- ZEV program? How will it change and how aggressive will it be?
- Feebates and vehicle incentive programs?
- Will auto industry be transformed (bankruptcy) and how will that affect rollout of advanced technology?
- How to support EV and H2 infrastructure? "Better Place," regional H2 rollouts, other?
- Cap and trade vis-à-vis LCFS/RFS

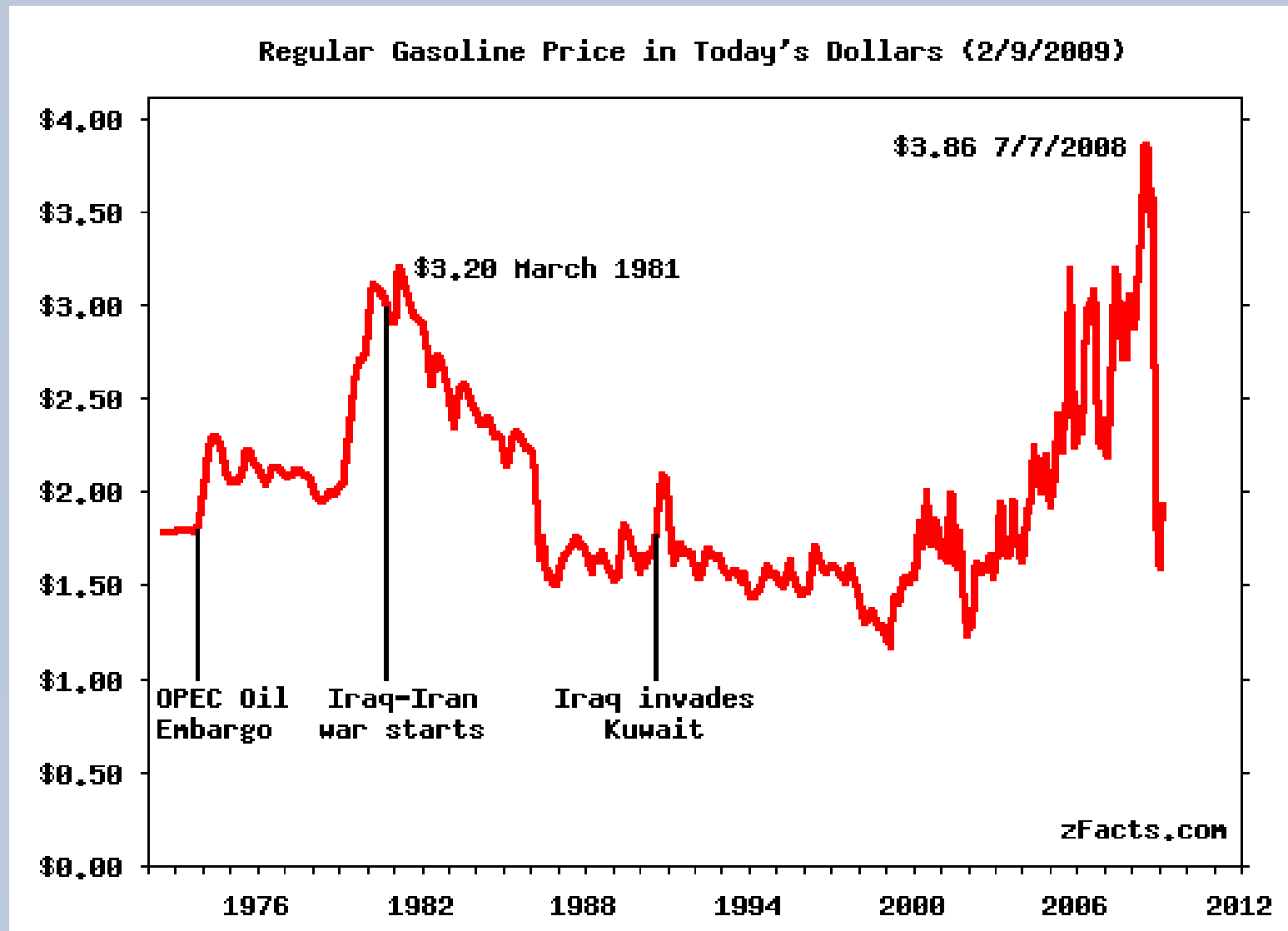
Why Gov't Initiative is Needed

A Long List of Market “Failures”

- **Environmental and energy externalities**
- **Principal agent problem** (rental cars, truck trailers, leased vehicles, cars for legislators/execs)
- **Network externality.** Complementary products requiring large *non-recoverable* investments and investments that cannot be made by individual consumers—such as when different vehicles or different infrastructures are required (H2, bike paths for biking, smart paratransit, etc)
- **Technology lock-in**
- **Market power** (cartels, oligopolies, etc)
- **High entry barriers in auto industry**
- **R&D under-investment** due to:
 - industry diffusion (ag industry)
 - R&D spillovers. When R&D findings cannot be fully captured (leading to under-investment in R&D)
 - Learning-by-doing spillovers where mfg savings not fully captured
- **Consumer cognition** (eg, buying cars), resulting in under-investment in efficiency (related to information and loss-aversion)
- **Volatile oil prices** create uncertainty which leads to under-investment in alternatives

Ultimate Challenge: How to “Tame” Gasoline Prices?

Increased gas tax? Gasoline price floor?



5 Point Program to Transform Transportation

1. Increased R&D investments (and training of next generation of scientists and engineers)
 - Batteries, fuel cells, and lightweight materials
2. Accelerate advanced vehicle commercialization
 - Near-zero emissions requirement (California ... and US?)
 - EU 50 g/km incentive
 - Tax credits for hybrids, fuel cell, battery-electric vehicles
3. Performance Standards for fuel/GHGs
 - CAFE, California Pavley Law, EU g/km stds
 - LCFS (to accelerate use of low-carbon fuels in vehicles)
4. Market instruments to align regulations with market
 - Feebates
 - Fuel price floor (also reduces uncertainty and risk for automakers, alt fuel providers, and advanced technology entrepreneurs)
5. Reform institutions and realign incentives to reduce sprawl and VMT
 - Reform transport funding to reward environmental/VMT performance and stimulate investment in new mobility services
 - Remove incentives for sprawl (fiscalization of LU, zoning, engineering rules)

It won't be easy ...

"We stand at a crossroads. One path leads to despair, the other to destruction. Let's hope we choose wisely."
Woody Allen

I'm more optimistic despite much evidence to the contrary...

